

# A Study on Measurement of Factors Used In Image Processing Techniques to Diagnose The Glaucoma

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## ABSTRACT

The glaucoma disease causes the loss of vision in eye due to intraocular pressure of eye and it damage the optic nerve system. The optic nerve is bundle of one millions nerve fibers and it transmits the visual signals from eye to brain. Advanced glaucoma may leads to blindness. The most common form glaucoma is open angle glaucoma causes due to increased fluid pressure of eye. Though, not all increased pressure will develop glaucoma. High pressure causes the damage of optic nerve. The less common type of glaucoma is acute angle closure glaucoma; it occurs due increased pressure of eye. This paper discusses the important factors that are considered to diagnose the glaucoma disease. Many factors to detect glaucoma disease are intraocular pressure, central corneal thickness, appearance of the chamber angle, optic nerve appearance, blood vessels and nerve fiber layer. It described the measurement of each factor and finally possible to find the factor(s) used to diagnose the glaucoma disease. The image processing technique use optic nerve parameter and cup disc ratio. Apart from these methods image processing techniques can use blood vessels displacement and Rretinal Nerve Fiber Layer (RNFL) thickness.

**Key words:** optic nerve,blood vessels,intraocular pressure, Rretinal Nerve Fiber Layer (RNFL) , image processing techniques

## 1. INTRODUCTION

It is important to detect the glaucoma early to prevent loss of vision in eye. Diagnosing the glaucoma based on several factors; intraocular pressure, central corneal thickness, optic nerve appearance, blood vessels and nerve fiber layer [1]. Imaging system, such as color fundus camera, Optical Coherence Tomography (OCT), Heidelberg retina tomography (HRT) and scanning laser polarimetry have been extensively used for diagnosis of glaucoma disease. However, those equipments are very expensive [1]. Various techniques and algorithms are used to diagnose the glaucoma [2-8]. Some of them are based on image segmentation of the cup/disc ratio (CDR) measurement. Other methods use texture analysis to detect retinal nerve layer defects [2-8]. This paper present factors to detect glaucoma.

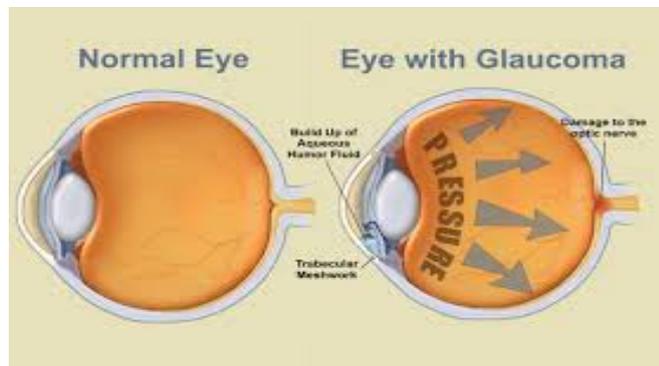
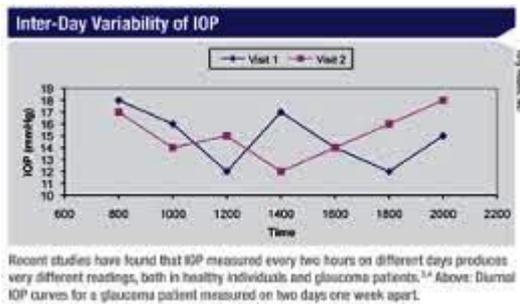
## 2. METHODS

### 2.1 Intraocular Pressure (IOP)

Intraocular pressure (IOP) is the primary risk factor for the development of glaucoma and it is modifiable one. The tonometer measures the pressure in your eye. Eye pressure is measured in millimeters of mercury (mm Hg) IOP is normal, if it is between 10 to 22mmHg. IOP is dynamically changed. The IOP is depends on combination of three factors,

- The amount of fluid within the eye, which is determined by the balance of aqueous humour production and drainage
- External forces acting upon the eye, including the tension within the ocular walls themselves
- The intraocular volume.

It affects the Retinal Nerve Fiber Layer (RNFL), loss of the neuroretinal rim and substantial functional loss and Retinal Ganglion Cell (RGC) death[9]. Only by using the intraocular pressure cannot diagnose the glaucoma eye, must include the other factors like visual field and optical nerve system. The following figure shows the variations of IOP and eye with glaucoma due to high IOP.



### 2.2 Central Corneal Thickness (CCT)

Central Corneal Thickness (CCT) is used to measure the IOP levels. Pachymeter is used to measure the CCT. Several studies shown that IOP alone is not a factor to identify the glaucoma , include the CCT factor while measuring the IOP.CCT has been associated with underestimation of IOP. It has been shown that Goldmann applanation tonometry over/underestimates IOP by as much as 5mmHg for every 70 mm corneal thickness above or below the mean. In a study by Shah et al,normal eyes had a mean CCT of 554  $\mu$ m. The POAG (Primary Open Angle Glaucoma) eyes had a mean CCT of 550  $\mu$ m, the NTG (Normal Tension Glaucoma) eyes had a mean CCT of 514  $\mu$ m, and the OHT (ocular Hypertension) eyes had a mean CCT of 580  $\mu$ m [10].

The central corneal thickness was sub-grouped using a range of 10  $\mu\text{m}$  for each subgroup, and the table shows the thickness of the CCT using number of controls and primary open angle glaucoma [11],

Central corneal thickness ( $\mu\text{m}$ )	Controls (No.)	Primary open angle glaucoma (No.)
450-460	1	0
461-470	1	0
471-480	2	4
481-490	7	3
491-500	2	3
501-510	9	13
511-520	18	14
521-530	6	8
531-540	9	23
541-550	12	6
551-560	5	8
561-570	8	12
571-580	7	2
581-590	7	1
591-600	4	1
601-610	1	1
611-620	1	1

A meta-analysis showed that the IOP-CCT interrelationship was different for glaucomatous and non-glaucomatous eyes. They concluded that for normal eyes, a 53 mm difference in CCT would be expected to produce a 1.1mmHg shift in the measured IOP.

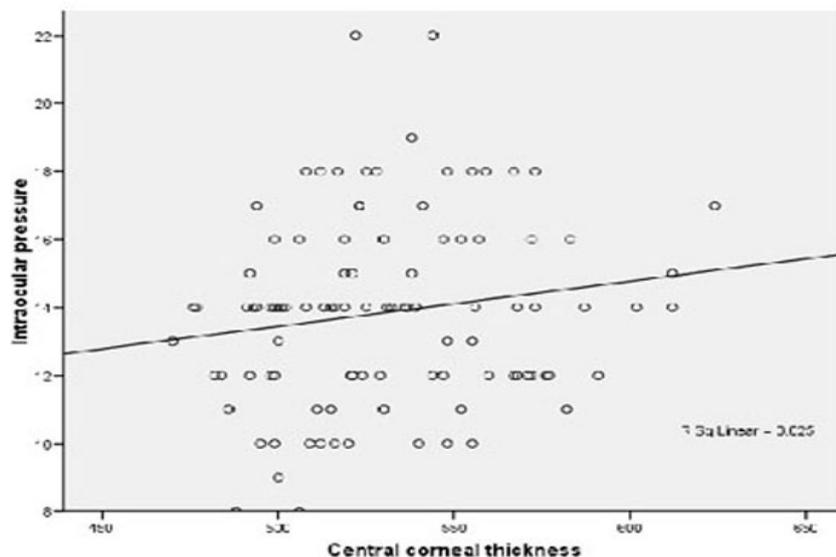
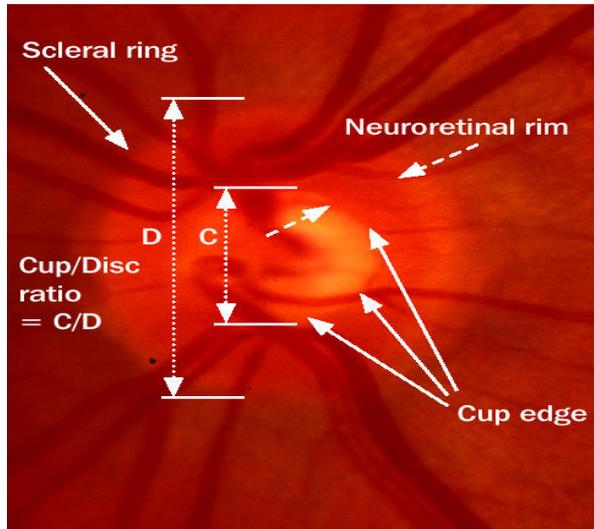


Figure 2: Scatterplot demonstrating the correlation between central corneal thickness (micrometers) and intraocular pressure in the study population. The correlation is not statistically significant ( $r = 0.158$ ,  $p = 0.12$ ).

### 2.3 Optic Nerve Appearance

IOP damage the fiber optic nerve system, it is not reversible because of the nerve fibers does not have capability to regenerate the optic nerve. Most of the research papers to diagnose the glaucoma disease based on optic nerve damages [12-13]. To diagnose the glaucoma using optic disc and optic cup, first need to evaluate the size of the disc because the size of the disk and size of the cup are interrelated. Thus, a normal, large disc will have a large cup, and a

normal, small disc will have a small cup. Calculate cup and disc ratio is range between the disc and cup of the optic nerve system. The following figures shows the C/D ratio,

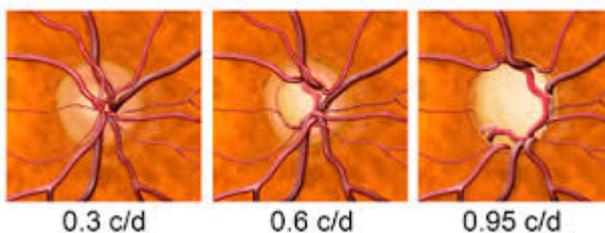


C/D ratios ranging from less than 0.3 (66 percent of normal individuals) to greater than 0.5 (only 6 percent of normal individuals).<sup>7</sup> The classification is as follows:

- A C/D ratio less than 0.4 usually denotes a non-glaucomatous nerve unless the patient has an abnormally small optic disc size (which then requires further investigation);
- A C/D ratio between 0.4 and 0.8 can characterize a patient with a normal optic disc (i.e., physiologic cupping), a glaucoma suspect or someone with early to moderate glaucoma (depending on the optic disc size);
- If the C/D ratio is 0.8 or greater, consider the individual's disc as glaucomatous unless proven otherwise.

Based on the above classification classify the image of eye to diagnose the glaucoma using image processing techniques. The following figure shows the optic nerve head cupping progression due to glaucoma,

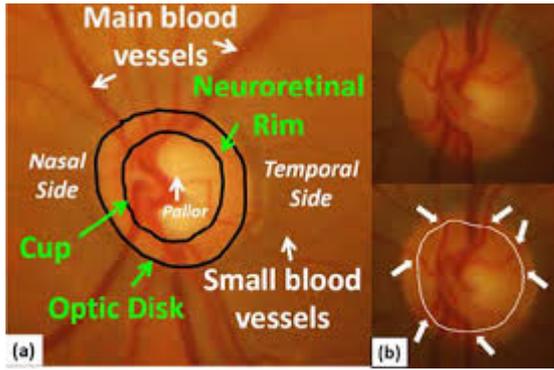
Optic nerve head cupping progression



The high IOP

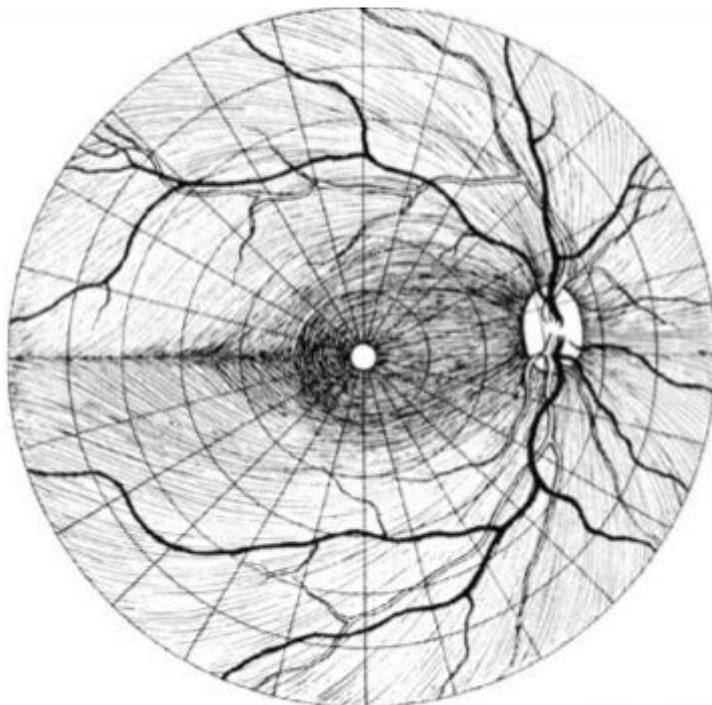
## 2.4 Blood Vessels

The occurrence of glaucoma increases the size of the cup size. Then the result of cupping replaces the blood vessels and cup makes a sharp bend as it cross the cup margin. Displacements of blood vessels take place when the cup size increased due to neural loss.



### 2.5 Nerve Fiber Layer

Retinal Nerve Fiber Layer (RNFL) thickness measurements around the optic disk were taken with circular spectral domain optical coherence tomography (SD-OCT) scans. RNFL thickness measurement is lower in glaucomatous eye.



### Conclusion:

Glaucoma can occur without high IOP, So examination of optic nerve and vision field testing is essential factor to diagnose the glaucoma. Most of the image processing technique use the cup and disc ratio or optic nerve damage. Use other parameters like displacement of blood vessels and Retinal Nerve Fiber Layer (RNFL) thickness to diagnose the glaucoma. This paper discussed about various factor need to be considered to diagnose the glaucoma.

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